

I-40 Corridor Profile Study

ARIZONA/CALIFORNIA STATE LINE TO JUNCTION I-17

ADOT Work Task No. MPD 072C-14

ADOT Contract No. DT11-013152

DRAFT WORKING PAPER 5: STRATEGIC SOLUTIONS

OCTOBER 2015

PREPARED FOR:

ARIZONA DEPARTMENT OF TRANSPORTATION



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LIST OF ACRONYMS AND ABBREVIATIONS

ABBREVIATION	NAME
ADOT	Arizona Department of Transportation
bqAZ	Building a Quality Arizona
CCTV	Closed Circuit Television
DMS	Dynamic Message Sign
I	Interstate
LRTP	Long-Range Transportation Plan
MP	Milepost
MPD	Multimodal Planning Division
P2P Link	Planning to Programming Linkages
RWIS	Road Weather Information System
SR	State Route
WIM	Weigh-in-Motion

1 INTRODUCTION

1.1 Study Purpose

The Arizona Department of Transportation (ADOT) is conducting corridor profile studies for strategic corridors in the State of Arizona. Interstate 40 (I-40) is one of those strategic corridors. The purpose of a corridor profile study is to provide insight and results to connect the strategic visions developed in Building a Quality Arizona (bqAZ) to performance-based planning and programming processes known as Planning to Programming Linkages (P2P Link) that satisfy both funding constraints and progress towards realizing the bqAZ vision. In support of this study purpose, the I-40 Corridor Profile Study, Arizona/California State Line to Junction I-17, will define and address current and future needs in the I-40 corridor using a study process that can be applied in other corridor profile studies to establish priorities for improving Arizona’s strategic corridors.

This study, as well as other corridor profile studies, will be guided by processes developed in P2P Link. P2P Link is a performance-based approach to planning, programming, and financial decisions that ensures that available funds are used in the most productive way to meet overall transportation system performance objectives. The P2P Link connects the investment strategies of the State’s Long-Range Transportation Plan (LRTP) to ADOT’s Five-Year Construction Program. This connection ensures that the policy guidance in the LRTP is adhered to in improving the State transportation system.

1.2 Study Objectives

Objectives of the I-40 Corridor Profile Study are:

Collaborate with ADOT and others to maximize procedural consistency among all corridor profile studies.

Assess the existing performance of the corridor. Existing corridor performance will be assessed using the performance measures developed in P2P Link to ensure consistency. Input from past studies, completed projects, and the current construction program will be reviewed to determine the track-record of corridor improvements and investment strategies over recent years.

Identify performance-based emphasis areas for the corridor. The corridor will be defined in terms of future performance objectives for key emphasis areas. These emphasis areas will guide corridor preservation, modernization, and expansion.

Determine the health of the corridor and identify performance-based needs that must be addressed to achieve the performance objectives for the corridor emphasis areas. Existing performance will be compared with identified performance objectives to define corridor needs.

Develop and evaluate solution sets and corresponding investment strategies that will lead to achieving the performance objectives for the corridor emphasis areas. Corridor solution sets will be developed to advance the corridor toward its performance objectives.

Scope and prioritize solution sets and projects using criteria consistent with P2P Link and a risk assessment approach. Project scoping is a critical step to transition from solution sets to project candidates. Project scoping will include appropriate emphasis on development issues and life cycle costing to ensure that recommendations are ready to be considered in a risk assessment framework before being considered as candidates for P2P selection and priority processes.

Document study procedures, measures, criteria, and relationships with the P2P Link to serve as guidance for future profile studies. A well-documented process will be a key requirement for creating consistency between the corridor profile studies and P2P Link selection and priority procedures.

1.3 Study Location and Corridor Segments

The location of the I-40 Corridor Profile Study is illustrated in **Figure 1**. The corridor study limits extend from milepost (MP) 0 at the Arizona/California state line to milepost 196, east of the I-40/I-17 freeway interchange. **Figure 1** also shows the fourteen corridor segments within the corridor study limits that are further described in **Table 1**.

Table 1: I-40 Corridor Segments

Segment Number	Begin Milepost	End Milepost	Length (miles)	Description
40-1	0	11	11	Topock, State Route (SR) 95, Lake Havasu
40-2	11	43	32	Yucca, Chrysler Arizona Proving Ground
40-3	43	55	12	Kingman, US 93
40-4	55	74	19	Blake Ranch, I-40/US 93
40-5	74	80	6	Silver Springs
40-6	80	98	18	Willow Creek
40-7	98	108	10	Jolly Rd
40-8	108	120	12	Anvil Rock
40-9	120	143	23	Seligman, Route 66
40-10	143	160	17	Ash Fork, SR 89, Pine Springs
40-11	160	168	8	Williams, SR 64
40-12	168	184	16	Parks
40-13	184	190	6	Bellemont
40-14	190	196	6	West Flagstaff

1.4 Working Paper 5 Objective

The objective of Working Paper 5 is to develop and document strategic solutions that are expected to positively impact corridor and segment performance based on the needs assessment of the I-40 corridor.

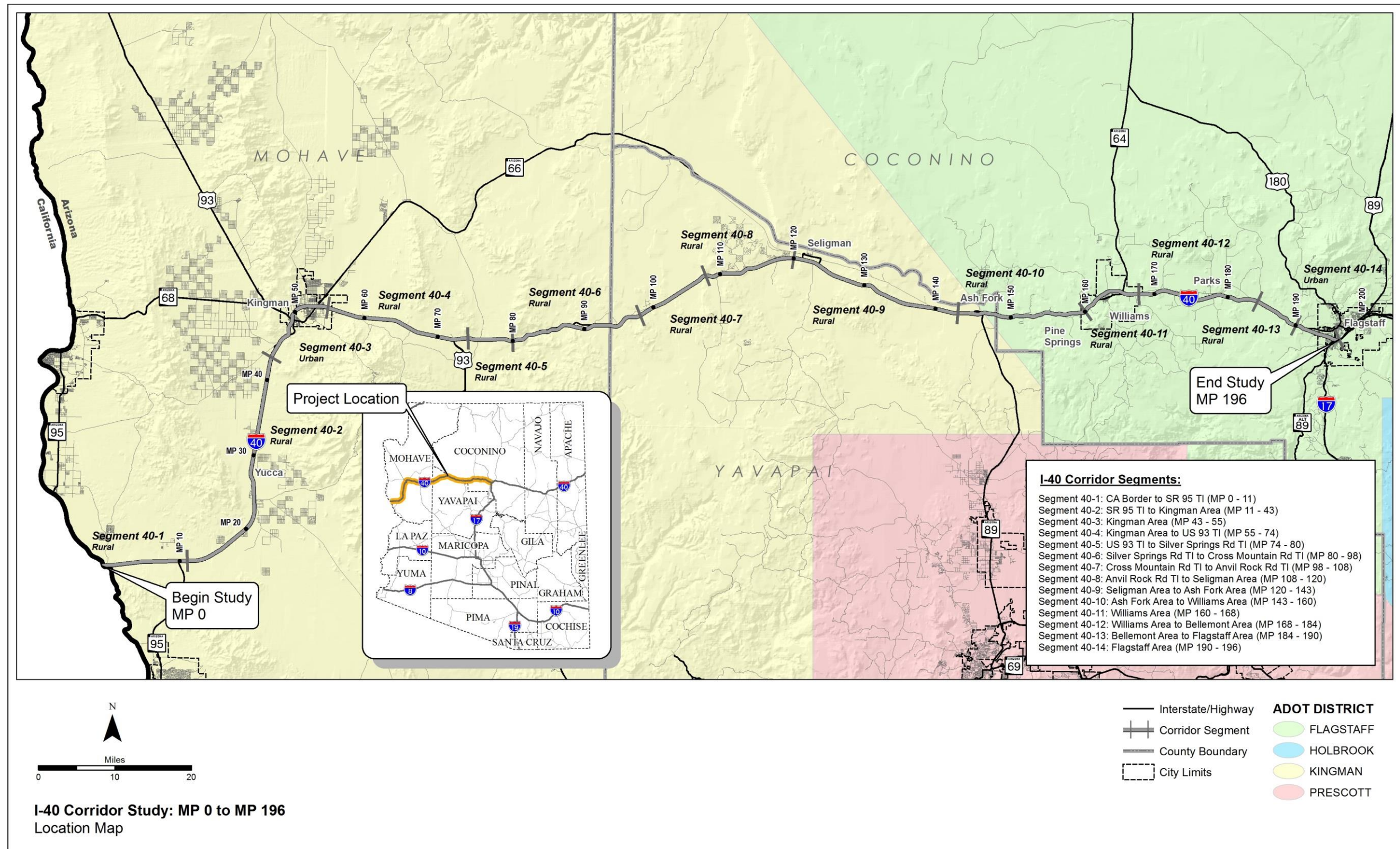


Figure 1: Location Map and Corridor Segments

2 SUMMARY OF CORRIDOR NEEDS

2.1 Summary of Needs

Working Paper 4 documented the performance-based needs assessment process and the results for the I-40 corridor. The needs in each performance area were classified as either None, Low, Medium, or High based on a comparison of the corridor performance (Working Paper 2) to the performance objectives (Working Paper 3).

As documented in Working Paper 4, the needs for each segment were numerically combined to estimate the average level of need for each corridor segment. During the corridor study process for I-40, the Pavement, Bridge, and Safety performance areas were identified as emphasis areas. Therefore, during the calculation process a weighting factor of 1.50 was applied to the average need score in these performance areas. The table at the bottom of **Figure 2** shows the level of need for each segment by performance area, and the numeric average need for each segment.

Following the distribution of Working Paper 4 (Needs Assessment), modifications were made to the performance system and the needs assessment process as the process has continued to evolve to address stakeholder input and meet project needs. As such, the needs described below and shown in **Figure 2** differ somewhat from those that had been shown previously in Draft Working Paper 4. The bullets below and referenced figure reflect the current needs analysis results for the I-40 corridor and are the basis for the evaluation and resulting candidate solutions of this working paper.

Pavement Performance Area

- Pavement is an emphasis area for the I-40 corridor.
- Nine of the fourteen corridor segments exhibit some level of need relative to the pavement performance measures. Segment 11 and Segment 13 have high levels of need. Seven segments have low levels of need.
- Eight of the segments contain pavement hot spots, or areas of failure condition.
- Programmed improvements are in the current ADOT five-year construction program for the two segments with high levels of need as well as for many other segments with low levels of need.
- Segments 1, 10, 12, and 14 have experienced generally high levels of historical investment, suggesting there may be sub-surface issues that cause the pavement surface to deteriorate more quickly than is typically expected.

Bridge Performance Area

- Bridge is an emphasis area for the I-40 corridor.
- Thirteen of the fourteen corridor segments exhibit some level of need relative to the bridge performance measures. Segment 1 and Segment 12 have high levels of need. Four segments have medium levels of need and seven segments have low levels of need.
- Ten of the segments contain bridge hot spots, or bridges with a rating of 4 or multiple ratings of 5.
- There are no programmed improvements in the current ADOT five-year construction program for the two segments with high levels of need. Approximately 50% of the bridges with deficiencies have programmed improvements in the ADOT five-year construction program.

- All of the segments except Segment 12 contain bridges identified in the historical review within Working Paper 4 for further analysis.

Mobility Performance Area

- Mobility is not an emphasis area for the I-40 corridor.
- Thirteen of the fourteen corridor segments exhibit some level of need relative to the mobility performance measures. Segment 3 is the only segment with a high level of need. Twelve segments have low levels of need.
- The Segment 3 high level of need is due to a combination of moderate existing recurring and non-recurring congestion and anticipated significant future traffic growth.
- There are no programmed improvements in the ADOT five-year construction program that directly relate to the mobility needs on the I-40 corridor.

Safety Performance Area

- Safety is an emphasis area for the I-40 corridor.
- Eight of the fourteen segments exhibit some level of need relative to the safety performance measures. Segments 1, 4, 6, and 10 have high levels of need. Four segments have medium levels of need. Most of these segments have a higher percentage of single vehicle, speed-related, and road departure crashes than the statewide average percentage.
- Two of the segments – Segment 3 and Segment 10 – contain safety hot spots, or areas of concentration.
- There are a few programmed improvements in the ADOT five-year construction program that could potentially affect the safety performance of the I-40 corridor, but it is not clear what those impacts will be, as the programmed safety improvements are relatively minor in scale.

Freight Performance Area

- Freight is not an emphasis area for the I-40 corridor.
- Eleven of the fourteen corridor segments exhibit some level of need relative to the freight performance measures. No segments have a high or medium level of need. Eleven segments have low levels of need.
- Two of the segments – Segment 3 and Segment 8 – contain freight hot spots, or locations with substandard overhead bridge clearance that do not provide opportunities to ramp around the clearance restriction.

2.2 Strategic Investment Areas

In an effort to focus on the most significant issues identified throughout the corridor, only needs that will result in strategic investment will be considered for solutions. Candidates for strategic investment include segments with elevated High and Medium level needs, as well as any segment with an identified hot spot. Addressing these areas of medium or high need has the greatest effect on the corridor performance and should be the focus of the strategic solutions. Segments with None or Low levels of need and no apparent hot spots are not considered candidates for strategic investment and will likely be addressed through other ADOT programming processes.

Per this criteria, the needs on the I-40 segments have been filtered to only consist of those needs that qualify for strategic investment consideration. **Figure 3** illustrates the resulting strategic investment areas identified for the I-40 corridor.

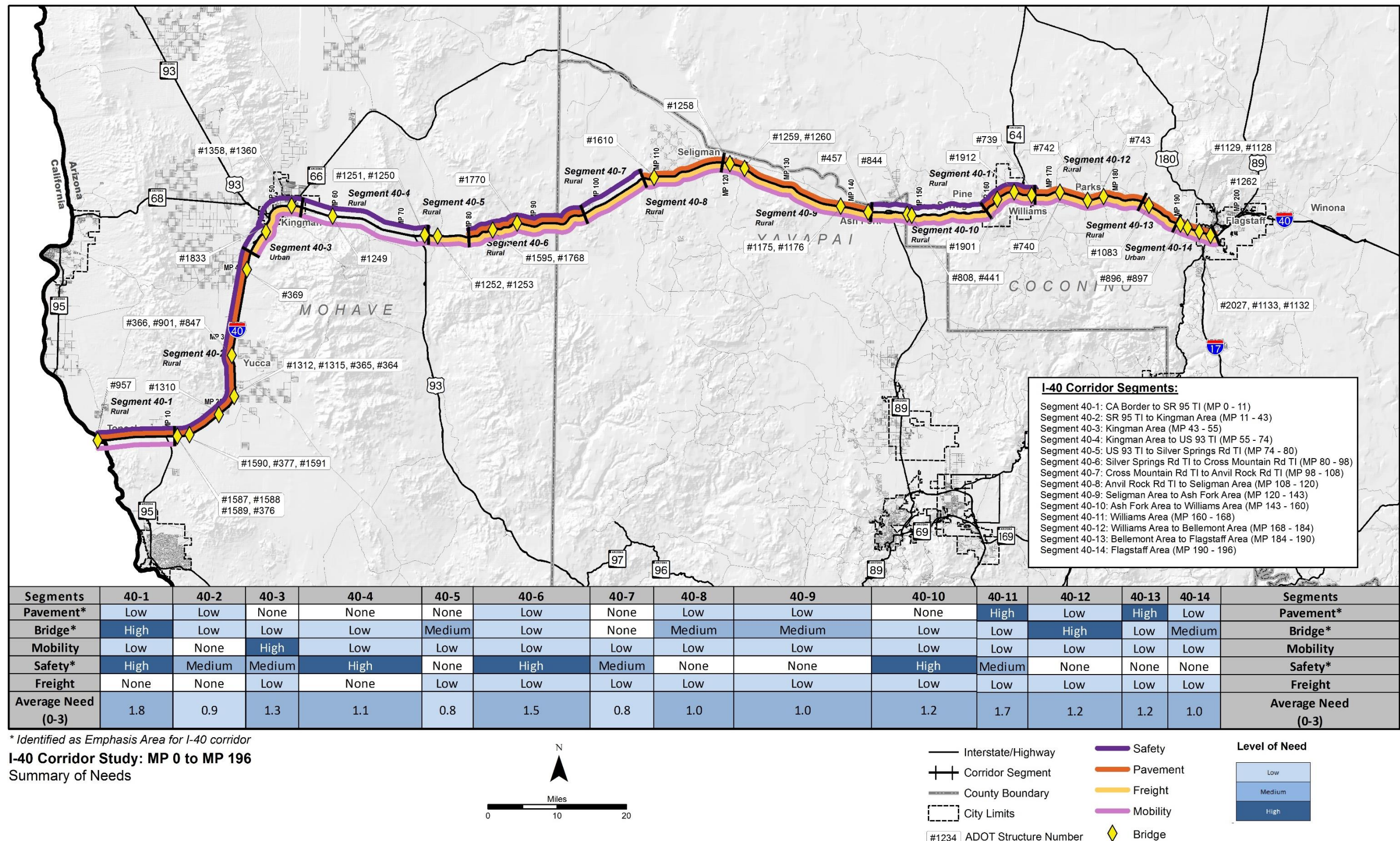
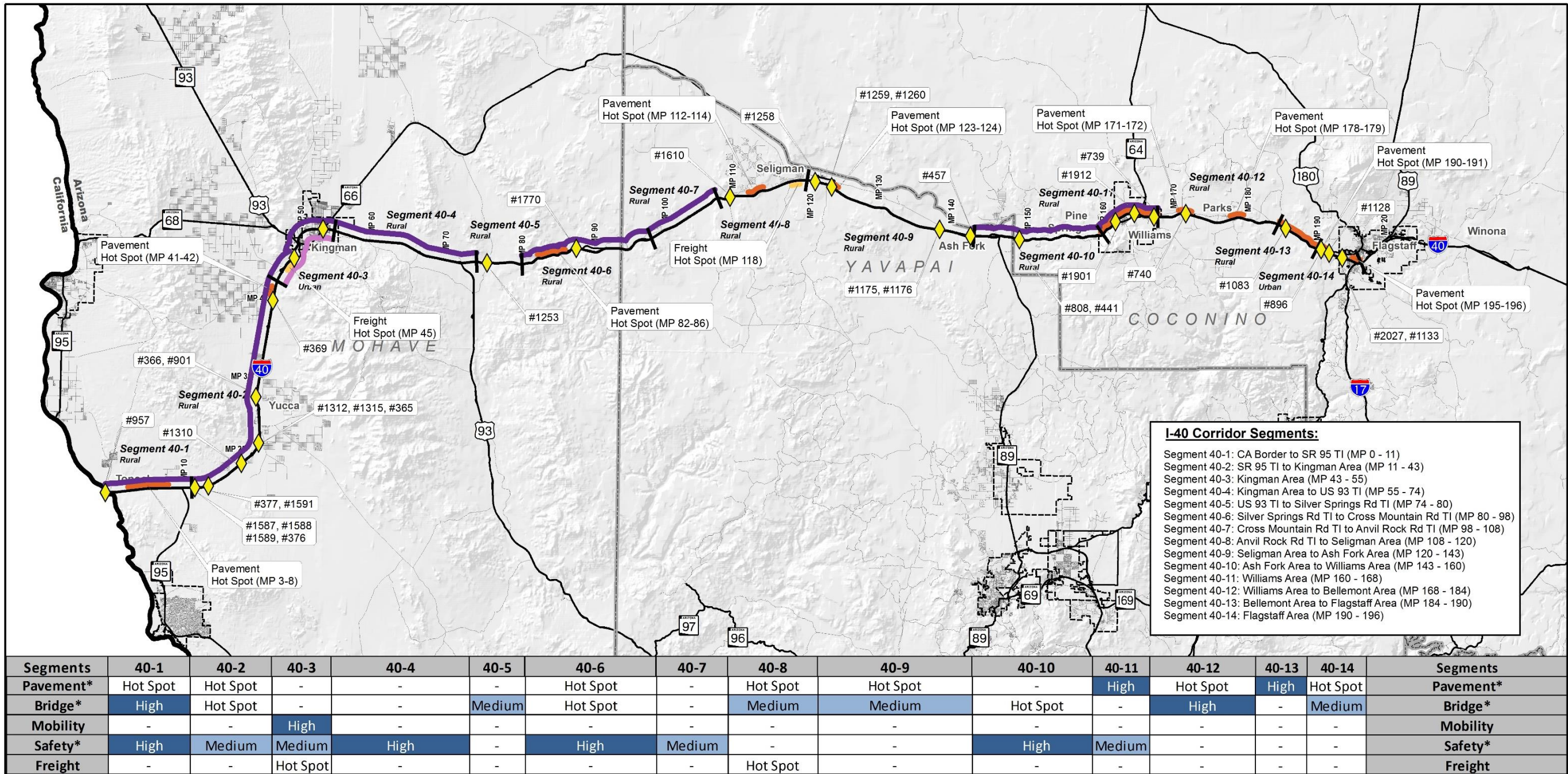


Figure 2: Summary of Needs



* Identified as Emphasis Area for I-40 corridor

I-40 Corridor Study: MP 0 to MP 196
Strategic Investment Areas

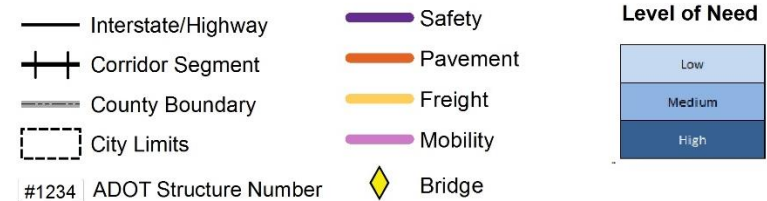
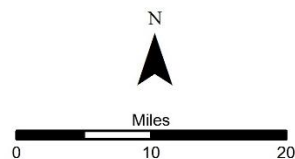


Figure 3: Strategic Investment Areas

3 STRATEGIC INVESTMENT AREA SCREENING

This section examines the needs identified in Section 2 that qualify for strategic investment and determines if the needs in those locations are actionable. In some cases, needs that have been identified will not be advanced to solution development but rather will be screened out from further consideration because they have been, or will soon be, addressed through other measures. A need will not be advanced to solution development if any of the following screening criteria are met:

- A project has already been programmed to address the need.
- The need is a pavement hot spot that does not show high levels of historical investment (as identified in Working Paper 4). This hot spot will likely be addressed through current ADOT pavement maintenance and preservation programming processes.
- The need is a bridge hot spot that was not identified in the historical review within Working Paper 4 for further analysis. This hot spot will likely be addressed through current ADOT bridge maintenance and preservation programming processes.
- A bridge is not a hot spot but is located within a segment with a Medium or High level of need. This bridge will likely be addressed through current ADOT bridge maintenance and preservation programming processes.

- The conditions and characteristics of the location have changed since the performance data was collected that was used to identify the need.
- The need is determined to be ‘non-actionable’ (e.g., mobility issues due to a border patrol checkpoint).

Table 2 provides specific information about each strategic investment area. Locations identified in a segment with a Medium or High level of need or a hot spot merit consideration for a strategic investment. Each area of need has been assigned a Location Number to help document and track specific locations throughout this process that are being considered for strategic investment.

For each location, the identified need is characterized to help identify potential causes and situational context to help identify potential solutions. Each need is then assessed against the previously listed screening criteria to determine if it should be advanced to solution development.

Locations advancing to solution development are marked with a Yes (Y); locations not advancing are marked with a No (N) and grayed out. The table also provides detailed reasoning for the screening decision to inform solution development. The remainder of the study will focus on developing appropriate solutions for the advancing locations.

Table 2: Strategic Investment Area Screening

Segment	Level of Strategic Need					Need Description	Location #*	Advance to Solution Development? (Y/N)*	Reasons for Screening Decision*
	Pavement	Bridge	Mobility	Safety	Freight				
40-1 (MP 0-11)	Hot Spot	High		High		Pavement need: Failure hot spot at MP 3-8 with subgrade issues causing heaving and large cracks; high historical investment	L1	Y	No programmed project to address pavement need; high historical investment
						Bridge need: Colorado River Bridge #957 at MP 0 has deck rating of 3; identified in historical review; Caltrans responsibility with ADOT as financial partner	L2	N	Caltrans has already begun scoping process for improvements and coordination with ADOT to address need
						Safety need: MP 0-11 has above average vehicle-vehicle and run-off road crashes; likely contributing factors include road departure, inattention/distraction, fatigue, pavement surface condition, shoulder/rumble strip condition, lack of restraint usage, and improper lane changes	L3	Y	No programmed project to address safety need; crash types align with ADOT Strategic Highway Safety Plan (SHSP) behavior emphasis areas
40-2 (MP 11-43)	Hot Spot	Hot Spot		Medium		Pavement need: Failure hot spot WB at MP 41-42; medium historical investment	L4	N	No high historical investment; will likely be addressed by current ADOT processes
						Bridge need: Boulder Wash EB #1587 at MP 11 has deck and superstructure ratings of 5; not identified in historical review	L5	N	Not identified in historical review; Programmed project in FY 2016 expected to address deck need; superstructure need will likely be addressed by current ADOT processes
						Bridge need: Boulder Wash WB #1588 at MP 11 has deck and superstructure ratings of 5; not identified in historical review	L6	N	Not identified in historical review; will likely be addressed by current ADOT processes
						Bridge need: Chemehuevi Wash EB #1589 at MP 12 has deck and superstructure ratings of 5; not identified in historical review	L7	N	Not identified in historical review; will likely be addressed by current ADOT processes
						Bridge need: Chemehuevi Wash WB #376 at MP 12 has deck and superstructure ratings of 5; not identified in historical review	L8	N	Not identified in historical review; will likely be addressed by current ADOT processes

* Gray cell indicates need does not meet criteria for solution development and will be screened out.

Table 2: Strategic Investment Area Screening (continued)

Segment	Level of Strategic Need					Need Description	Location #*	Advance to Solution Development? (Y/N)*	Reasons for Screening Decision*
	Pavement	Bridge	Mobility	Safety	Freight				
40-2 (MP 11-43)	Hot Spot	Hot Spot		Medium		Bridge need: Franconia Wash EB #1591 at MP 13 has deck and superstructure ratings of 5; not identified in historical review	L9	N	Not identified in historical review; will likely be addressed by current ADOT processes
						Bridge need: Franconia Wash WB #377 at MP 13 has deck and superstructure ratings of 5; identified in historical review	L10	Y	No programmed project to address bridge need; identified in historical review
						Bridge need: Illavar Wash EB #1310 at MP 18 has deck and superstructure ratings of 4; identified in historical review	L11	Y	Programmed project in Fiscal Year (FY) 2016 expected to address deck need but no programmed project to address superstructure; identified in historical review
						Bridge need: Flat Top Wash WB #1312 at MP 21 has deck and superstructure ratings of 5; identified in historical review	L12	Y	No programmed project to address bridge need; identified in historical review
						Bridge need: MacKensie Wash EB #1315 at MP 24 has deck and superstructure ratings of 5; not identified in historical review	L13	N	Not identified in historical review; will likely be addressed by current ADOT processes
						Bridge need: MacKensie Wash WB #365 at MP 24 has deck and superstructure ratings of 5; not identified in historical review	L14	N	Not identified in historical review; will likely be addressed by current ADOT processes
						Bridge need: Rock Creek EB #366 at MP 28 has deck and superstructure ratings of 5; not identified in historical review	L15	N	Not identified in historical review; will likely be addressed by current ADOT processes
						Bridge need: Rock Creek WB #901 at MP 28 has deck and superstructure ratings of 5; not identified in historical review	L16	N	Not identified in historical review; will likely be addressed by current ADOT processes
						Bridge need: Griffith Wash Br WB #369 at MP 40 has deck and superstructure ratings of 4; identified in historical review	L17	Y	No programmed project to address bridge need; identified in historical review
						Safety need: MP 11-43 has above average truck-related, single vehicle, and roadside object-related crashes; likely contributing factors include road departure, inattention/distraction, fatigue, pavement surface condition, shoulder/rumble strip condition, clear zone slopes, obstructions, and driving under the influence	L18	Y	No programmed project to address safety need; crash types align with ADOT Strategic Highway Safety Plan (SHSP) behavior and unit type emphasis areas
40-3 (MP 43-55)			High	Medium	Hot Spot	Mobility need: MP 43-55 has moderate existing recurring and non-recurring congestion with significant projected future traffic volume growth	L19	Y	No programmed project to address mobility need; congestion expected to worsen without improvements
						Safety need: MP 43-55 has above average rear end, head-on, and overturning crashes; likely contributing factors include median crossing, roadway departure, speeding, improper lane changes, pavement surface condition, shoulder/rumble strip condition, clear zone slopes and obstructions, urban operating conditions, driving under the influence, and lack of restraint usage	L20	Y	No programmed project to address safety need; crash hot spot exists EB/WB at MP 48-51
						Freight need: Low clearance (15'-10") McConnico Railroad Bridge at MP 45 with no ability to ramp around	L21	Y	No programmed project to address freight need; restricts freight flow
40-4 (MP 55-74)				High		Safety need: MP 55-74 has above average rear end crashes; likely contributing factors include speeding, improper lane changes, high traffic volume operating conditions, and driving under the influence	L22	Y	No programmed project to address safety need; crashes expected to increase as congestion increases in the future if improvements are not made

* Gray cell indicates need does not meet criteria for solution development and will be screened out.

Table 2: Strategic Investment Area Screening (continued)

Segment	Level of Strategic Need					Need Description	Location #*	Advance to Solution Development? (Y/N)*	Reasons for Screening Decision*
	Pavement	Bridge	Mobility	Safety	Freight				
40-5 (MP 74-80)		Medium				Bridge need: Big Sandy Wash WB #1253 at MP 75 has deck rating of 4; identified in historical review	L23	N	Programmed project in FY 2018 expected to address need
						Bridge need: Big Sandy Wash EB #1252 at MP 75 has deck rating of 5; identified in historical review	L24	N	Programmed project in FY 2018 expected to address need
40-6 (MP 80-98)	Hot Spot	Hot Spot		High		Pavement need: Failure hot spot at MP 82-86 with possible subgrade issues causing potholes; low historical investment	L25	N	Programmed project in FY 2019 expected to address need; no high historical investment
						Bridge need: Willow Ranch Rd TI UP #1770 at MP 88 has superstructure rating of 4; not identified in historical review	L26	N	Not identified in historical review; will likely be addressed by current ADOT processes
						Safety need: MP 80-98 has above average single vehicle, overturning, truck-related, and night-time crashes; likely contributing factors include speeding, inattention/distraction, road departure, pavement surface condition, traffic control device reflectivity, shoulder/rumble strip condition, clear zone slopes and obstructions, lack of restraint usage, and slippery/wet pavement	L27	Y	Programmed rockfall mitigation project in FY 2017 may help address crashes related to clear zone obstructions; no programmed project to address remaining safety need
40-7 (MP 98-108)				Medium		Safety need: MP 98-108 has above average single vehicle, overturning, and night-time crashes; likely contributing factors include speeding, road departure, traffic control device reflectivity, shoulder/rumble strip condition, clear zone slopes and obstructions, and slippery/wet pavement	L28	Y	No programmed project to address safety need
40-8 (MP 108-120)	Hot Spot	Medium			Hot Spot	Pavement need: Failure hot spot at MP 112-113 EB and MP 113-114 WB with possible subgrade issues causing potholes; low historical investment	L29	N	Programmed project in FY 2019 expected to address need; no high historical investment
						Bridge need: Anvil Rock Rd TI UP #1610 at MP 110 has deck rating of 4 and superstructure rating of 5; identified in historical review	L30	Y	No programmed project to address bridge need; identified in historical review
						Freight need: Low clearance (15'-11") Canyon Mouth Dam Road Bridge at MP 118 with no ability to ramp around	L31	Y	No programmed project to directly address freight need; restricts freight flow; programmed pavement project in FY 2019 could potentially be modified to address low clearance issue
40-9 (MP 120-143)	Hot Spot	Medium				Pavement need: Failure hot spot at MP 123-124 EB with possible subgrade issues causing large cracks; low historical investment	L32	N	Programmed project in FY 2019 expected to address need; no high historical investment
						Bridge need: W Seligman TI UP #1258 at MP 121 has deck rating of 4; not identified in historical review	L33	N	Not identified in historical review; will likely be addressed by current ADOT processes
						Bridge need: E Seligman TI WB #1260 at MP 123 has deck and superstructure ratings of 5; not identified in historical review	L34	N	Not identified in historical review; will likely be addressed by current ADOT processes
						Bridge need: E Seligman TI EB #1259 at MP 123 has deck and superstructure ratings of 5; not identified in historical review	L35	N	Not identified in historical review; will likely be addressed by current ADOT processes
						Bridge need: Pineveta Draw EB #1175 at MP 139 has deck and superstructure ratings of 5; not identified in historical review	L36	N	Not identified in historical review; will likely be addressed by current ADOT processes
						Bridge need: Pineveta Draw WB #1176 at MP 139 has deck and superstructure ratings of 5; not identified in historical review	L37	N	Not identified in historical review; will likely be addressed by current ADOT processes

* Gray cell indicates need does not meet criteria for solution development and will be screened out.

Table 2: Strategic Investment Area Screening (continued)

Segment	Level of Strategic Need					Need Description	Location #*	Advance to Solution Development? (Y/N)*	Reasons for Screening Decision*
	Pavement	Bridge	Mobility	Safety	Freight				
40-9 (MP 120-143)	Hot Spot	Medium				Bridge need: Partridge Creek WB #457 at MP 143 has superstructure rating of 5; identified in historical review	L38	N	Bridge does not have a rating of 4 or multiple ratings of 5 so it is not a hot spot; will likely be addressed by current ADOT processes
40-10 (MP 143-160)		Hot Spot		High		Bridge need: Johnson Canyon EB #808 at MP 149 has deck and superstructure ratings of 5; not identified in historical review	L39	N	Not identified in historical review; will likely be addressed by current ADOT processes
						Bridge need: Johnson Canyon WB #441 at MP 149 has deck and superstructure ratings of 5; identified in historical review	L40	Y	No programmed project to address bridge need; identified in historical review
						Safety need: MP 143-160 has above average single vehicle and weather-related crashes; likely contributing factors include speeding, road departure, pavement surface condition, shoulder/rumble strip condition, clear zone slopes and obstructions, and slippery/wet pavement	L41	Y	No programmed project to address safety need; crash hot spot exists WB at MP 157-158
40-11 (MP 160-168)	High			Medium		Pavement need: MP 160-168 has failure hot spots at MP 160-161, MP 164-166, and MP 167-168 with possible subgrade issues causing potholes; medium historical investment	L42	N	Programmed projects in FY 2018 (MP 162-168) and FY 2019 (MP 161-165) expected to address need within those project limits; no high historical investment; no programmed project to address pavement need at MP 160-161 but will likely be addressed by current ADOT processes; ADOT could potentially expand programmed project limits to include MP 160-161
						Safety need: MP 160-168 has above average single vehicle, overturning, and weather-related crashes; likely contributing factors include speeding, inattention/distraction, fatigue, road departure, pavement surface condition, shoulder/rumble strip condition, clear zone slopes and obstructions, lack of restraint usage, and slippery/wet pavement	L43	Y	No programmed project to address safety need; crash types align with ADOT SHSP behavior emphasis areas
40-12 (MP 168-184)	Hot Spot	High				Pavement need: Failure hot spots at MP 171-172 and MP 178-179 with possible subgrade issues causing potholes; high historical investment	L44	N	Programmed project in FY 2018 expected to address pavement need
						Bridge need: Pittman Road TI #740 at MP 172 has deck and superstructure ratings of 5; not identified in historical review	L45	N	Not identified in historical review; will likely be addressed by current ADOT processes
						Bridge need: Spitz Springs Rd #742 at MP 176 has superstructure rating of 5; not identified in historical review	L46	N	Not identified in historical review; will likely be addressed by current ADOT processes
						Bridge need: Parks Road TI #743 at MP 178 has deck rating of 5; not identified in historical review	L47	N	Not identified in historical review; will likely be addressed by current ADOT processes
40-13 (MP 184-190)	High					Pavement need: MP 184-190 has failure hot spots at MP 186-189 with possible shoulder condition issues causing potholes, potentially due to lack of shoulder milling; medium historical investment	L48	N	Programmed project in FY 2019 expected to address pavement need

* Gray cell indicates need does not meet criteria for solution development and will be screened out.

Table 2: Strategic Investment Area Screening (continued)

Segment	Level of Strategic Need					Need Description	Location #*	Advance to Solution Development? (Y/N)*	Reasons for Screening Decision*
	Pavement	Bridge	Mobility	Safety	Freight				
40-14 (MP 190-196)	Hot Spot	Medium				Pavement need: Failure hot spots at MP 190-196 with possible subgrade issues causing potholes; high historical investment	L49	Y	Programmed project in FY 2019 expected to address need at MP 190-191; high historical investment; no programmed project to address pavement need at MP 191-196
						Bridge need: A-1 Mountain TI #896 at MP 191 has deck rating of 4; not identified in historical review	L50	N	Not identified in historical review; will likely be addressed by current ADOT processes
						Bridge need: Riordan ATSFRR OP #897 at MP 191 has structural evaluation rating of 5; not identified in historical review	L51	N	Not identified in historical review; will likely be addressed by current ADOT processes
						Bridge need: W Flagstaff TI WB #1129 at MP 192 has deck and superstructure ratings of 5; not identified in historical review	L52	N	Programmed project in FY 2019 expected to address deck need but no programmed project to address superstructure; not identified in historical review; will likely be addressed by current ADOT processes
						Bridge need: W Flagstaff TI EB #1128 at MP 192 has deck and superstructure ratings of 5; identified in historical review	L53	Y	Programmed project in FY 2019 expected to address deck need but no programmed project to address superstructure; identified in historical review
						Bridge need: Flag Ranch TI EB #2027 at MP 193 has deck and superstructure ratings of 5; identified in historical review	L54	Y	No programmed project to address bridge need; identified in historical review
						Bridge need: Woody Mountain Road TI EB #1132 at MP 194 has superstructure rating of 5; identified in historical review	L55	N	Bridge does not have a rating of 4 or multiple ratings of 5 so it is not a hot spot; will likely be addressed by current ADOT processes
						Bridge need: Woody Mountain Road TI WB #1133 at MP 194 has deck and superstructure ratings of 5; identified in historical review	L56	Y	No programmed project to address bridge need; identified in historical review
						Bridge need: SR 89A WB #1262 at MP 195 has superstructure rating of 5; not identified in historical review	L57	N	Bridge does not have a rating of 4 or multiple ratings of 5 so it is not a hot spot; not identified in historical review; will likely be addressed by current ADOT processes

* Gray cell indicates need does not meet criteria for solution development and will be screened out.

4 CANDIDATE SOLUTIONS

The principal objective of the corridor profile study is to identify performance-based strategic solutions (investments) to help inform decision-making processes. This will enable ADOT to direct available funding resources to maximize the performance of the State's key transportation corridors. The corridor profile process is designed to mesh with the Planning to Programming Link (P2P) and identifies strategic solutions in one of three categories for investment:

- Preservation
- Modernization
- Expansion

The performance needs previously documented in Working Paper 4 serve as the foundation for developing strategic solutions. These potential investments are not intended to be a substitute or replacement for traditional ADOT project development processes where various candidate projects are developed for consideration in programming in the P2P Link process. Rather, strategic solutions are intended to complement ADOT's traditional project development processes through a performance-based analysis to identify needs in one or more of the five performance areas of Pavement, Bridge, Mobility, Safety, and Freight. Strategic solutions developed for key corridors will be considered along with other candidate projects in the ADOT programming process.

Solutions developed through this performance based analysis are strategic in that they:

- Do not recreate or replace results from normal programming processes
- May include programs or initiatives, areas for further study, and infrastructure projects
- Address elevated levels of need (high or medium) and hot spots
- Focus on investments in Modernization projects (to optimize current infrastructure)
- Address overlapping needs
- Reduce costly repetitive maintenance
- Extend the operational life of system and delay expansion
- Leverage programmed projects that can be expanded to address other strategic elements
- Provide measureable benefit (benefit/cost ratio, risk, life-cycle cost analysis, performance system, etc.)

The corridor profile study process evaluated the strategic investment areas and the associated needs previously identified to develop potential solutions that would meet the objectives listed above. The process used was collaborative with study teams from concurrent corridor profiles studies and with the ADOT project management team.

The combined study team evaluated the needs identified, reviewed collected information, and discussed approaches to identify underlying causes, context issues, and challenges to assist in developing candidate solutions. The team applied expertise and information from multiple

sources to develop one or more candidate solutions for each strategic investment area. These sources included:

- Prior completed studies (e.g., design concept reports, road safety assessment)
- Input from ADOT technical groups
- Input from ADOT Districts
- Observable trends from performance analysis
- Field reviews
- National best practices
- Professional judgment and experience

Establishing uniform solution types enables the corridor profile process to compare proposed solutions on and across corridors to determine the effectiveness at improving performance, including cost and risk comparisons to be undertaken in subsequent tasks. **Appendix A** provides a list of the preliminary solutions currently proposed for the I-17, I-19, and I-40 corridors. This list is separated into the three funding categories (Preservation, Modernization, or Expansion) along with other miscellaneous categories.

4.1 Construction Program Solutions

Following the screening process, strategic solutions were developed for each remaining location. **Table 3** contains the candidate strategic solution(s) for each location. In some cases, multiple candidate solutions are proposed for a single location. These options will be evaluated in subsequent tasks (Task 6) with the intent of identifying one recommended solution for each location. Task 6 will utilize life-cycle cost analyses and benefit-cost analyses to evaluate the options with the intent of selecting one recommended solution per location to advance to the risk analysis evaluation in Task 7. In locations where only one option has been developed, the next step will be to advance that solution directly to the risk analysis evaluation, where solutions will be prioritized. The locations and extents of the candidate solutions for potential inclusion in ADOT's five-year construction program are shown in **Figure 4**.

Each deficient location has been assigned a candidate solution number (e.g., CS40.1, CS40.2, etc.). The assigned CS number will provide tracking capability through the rest of the process. Where there are several options to address a given need, the options will all be assigned the same CS number as they all address the same need.

4.2 Other Corridor Solutions

Other corridor-specific solutions may also be identified during the development of solutions. These solutions would still be strategic but may involve corridor-specific programs or initiatives rather than location-based projects. At this time, no corridor-specific solutions are proposed on I-40.

4.3 Policies and Initiatives

In addition to location-specific needs, general corridor and system-wide needs were also identified through the corridor profile process. While these needs are more overarching and cannot be

individually evaluated through this process, it is important to document them as well. Therefore, a recommended policies and initiatives list was developed for consideration when programming future projects not only on I-40, but across the entire state highway system where the conditions are applicable. The following list, which is in no particular order of priority, was derived from the I-19, I-17, and I-40 corridor profile studies and will be expanded to include recommendations from subsequent corridors as they are developed.

- Install ITS conduit with all new infrastructure projects
- Prepare strategic plans for Closed Circuit Television (CCTV) camera and Road Weather Information System (RWIS) locations statewide
- Leverage power and communication at existing weigh-in-motion (WIM), dynamic messaging signs (DMS), and call box locations to expand ITS applications across the state
- Consider solar power for lighting and ITS where applicable
- Investigate ice formation prediction technology where applicable
- Conduct highway safety manual evaluation for all future programmed projects
- Develop infrastructure maintenance and preservation plans (including schedule and funding) for all pavement and bridge infrastructure replacement or expansion projects
- Develop standardized bridge maintenance procedures so districts can do routine maintenance work
- Review historical ratings and level of previous investment during scoping of pavement and bridge projects. In pavement locations that warrant further investigation, conduct subsurface investigations during project scoping to determine if full replacement is warranted
- For pavement rehabilitation projects, enhance the amount/level of geotechnical investigations to address issues specific to the varying conditions along the project
- Expand programmed and future pavement projects as necessary to include shoulders
- Expand median cable barrier guidelines to account for safety performance
- Install CCTV cameras with all DMS
- In locations with limited communications, use CCTV cameras to provide still images rather than streaming video
- Develop statewide program for pavement replacement
- Install additional continuous permanent count stations along strategic corridors to enhance traffic count data

Table 3: Candidate Solutions

Candidate #	Location #	Name	Beginning Milepost	Ending Milepost	Option*	Scope	Investment Category (Preservation [P], Modernization [M], Expansion [E])
CS40.1	L1	Topock Area Pavement Improvements	3	8	A	Rehabilitate pavement	P
					B	Replace pavement	M
CS40.2	L3	Stateline to SR-95 Safety Improvements	0	11	-	Rehabilitate shoulder and re-install rumble strips; Install high-visibility delineators and raised pavement markers	M
CS40.3	L10	Franconia Wash WB Bridge #377	13	13	A	Rehabilitate bridge	P
					B	Replace bridge	M
CS40.4	L11	Illavar Wash EB Bridge #1310	18	18	A	Rehabilitate bridge	P
					B	Replace bridge	M
CS40.5	L12	Flat Top Wash WB Bridge #1312	21	21	A	Rehabilitate bridge	P
					B	Replace bridge	M
CS40.6	L17	Griffith Wash WB Bridge #369	40	40	A	Rehabilitate bridge	P
					B	Replace bridge	M
CS40.7	L18	SR-95 to Kingman Safety Improvements	11	43	-	Rehabilitate shoulder and re-install rumble strips; Install high-visibility delineators and raised pavement markers; Provide driver information (advance notice of Rest Area)	M
CS40.8	L19/L20	Kingman Area Safety and Mobility Improvements	43	55	-	Rehabilitate shoulder and re-install rumble strips; Install high-visibility delineators and raised pavement markers; Install median cable barrier at MP 47-51; Construct climbing lane EB at MP 47-51; Implement Variable Speed Limits (VSL) at MP 47-53 EB/WB and integrate with existing Dynamic Message Sign (DMS) at MP 45 (EB) and MP 55 (WB) to provide driver information	M
CS40.9	L21	I-40 Profile Adjustment at McConnico Railroad Bridge	45	45	-	Re-profile roadway on I-40 mainline for 400' to correct low 15'10" clearance and provide 16' clearance; combine project with future pavement rehabilitation project in area to reduce costs	M
CS40.10	L22	Kingman to US 93 Safety Improvements	55	74	-	Construct climbing lane EB at MP 58-60; Install VSL at MP 58-71 EB/WB and integrate with existing DMS at MP 69 (EB) and with new DMS at MP 55 (EB) and MP 72 (WB) to provide driver information	M
CS40.11	L27	Willow Creek Safety Improvements	80	98	-	Construct climbing lane EB at MP 80-83 and MP 93-97; Implement VSL at MP 80-83 EB, MP 88-90 EB, and MP 93-97 EB and integrate with existing Road Weather Information System (RWIS) at MP 91 and new DMS at MP 79 (EB) and MP 98 (WB) to provide driver information	M
CS40.12	L28	Jolly Road Area Safety Improvements	98	108	-	Rehabilitate shoulder and re-install rumble strips; Install high-visibility delineators and raised pavement markers; Implement VSL at MP 101-104 EB/WB and integrate with new RWIS at MP 103 and new DMS at MP 100 (EB) and MP 105 (WB)	M
CS40.13	L30	Anvil Rock Rd TI UP Bridge #1610	110	110	A	Rehabilitate bridge	P
					B	Replace bridge	M
CS40.14	L31	I-40 Profile Adjustment at Canyon Mouth Dam Road Bridge	118	118	-	Re-profile roadway on I-40 mainline for 200' to correct low 15'11" clearance and provide 16' clearance as part of implementing programmed pavement rehabilitation in FY2019 at MP 118	M
CS40.15	L40	Johnson Canyon WB Bridge #441	148	148	A	Rehabilitate bridge	P
					B	Replace bridge	M
CS40.16	L41	Ash Fork to Williams Safety Improvements	143	160	-	Rehabilitate shoulder and re-install rumble strips; Install high-visibility delineators and raised pavement markers; Construct climbing lane EB at MP 151-152 and MP 156-159; Implement VSL at MP 151-159 EB/WB and integrate with existing RWIS at MP 154 and MP 159 and existing DMS at MP 144 (EB) and with new DMS at MP 160 (WB)	M

* '-' indicates only one solution is being proposed so there are no Option A and Option B for this solution

Table 3: Candidate Solutions (continued)

Candidate #	Location #	Name	Beginning Milepost	Ending Milepost	Option*	Scope	Investment Category (Preservation [P], Modernization [M], Expansion [E])
CS40.17	L43	Williams Area Safety Improvements	160	168	-	Rehabilitate shoulder and re-install rumble strips; Install high-visibility delineators and raised pavement markers; Construct climbing lane WB at MP 162-163; Implement VSL at MP 161-163 EB/WB and integrate with existing RWIS at MP 159 and existing DMS at MP 168 (WB) and with new DMS at MP 160 (EB)	M
CS40.18	L49	West Flagstaff Pavement Improvements	191	196	A	Rehabilitate pavement	P
					B	Replace pavement	M
CS40.19	L53	W Flagstaff TI EB #1128	192	192	A	Rehabilitate bridge - re-evaluate FY2019 deck rehab project	P
					B	Replace bridge - re-evaluate FY2019 deck rehab project	M
CS40.20	L54	Flag Ranch TI EB Bridge #2027	193	193	A	Rehabilitate bridge	P
					B	Replace bridge	M
CS40.21	L56	Woody Mountain Road TI WB Bridge #1133	194	194	A	Rehabilitate bridge	P
					B	Replace bridge	M

* ‘ – ’ indicates only one solution is being proposed so there are no Option A and Option B for this solution

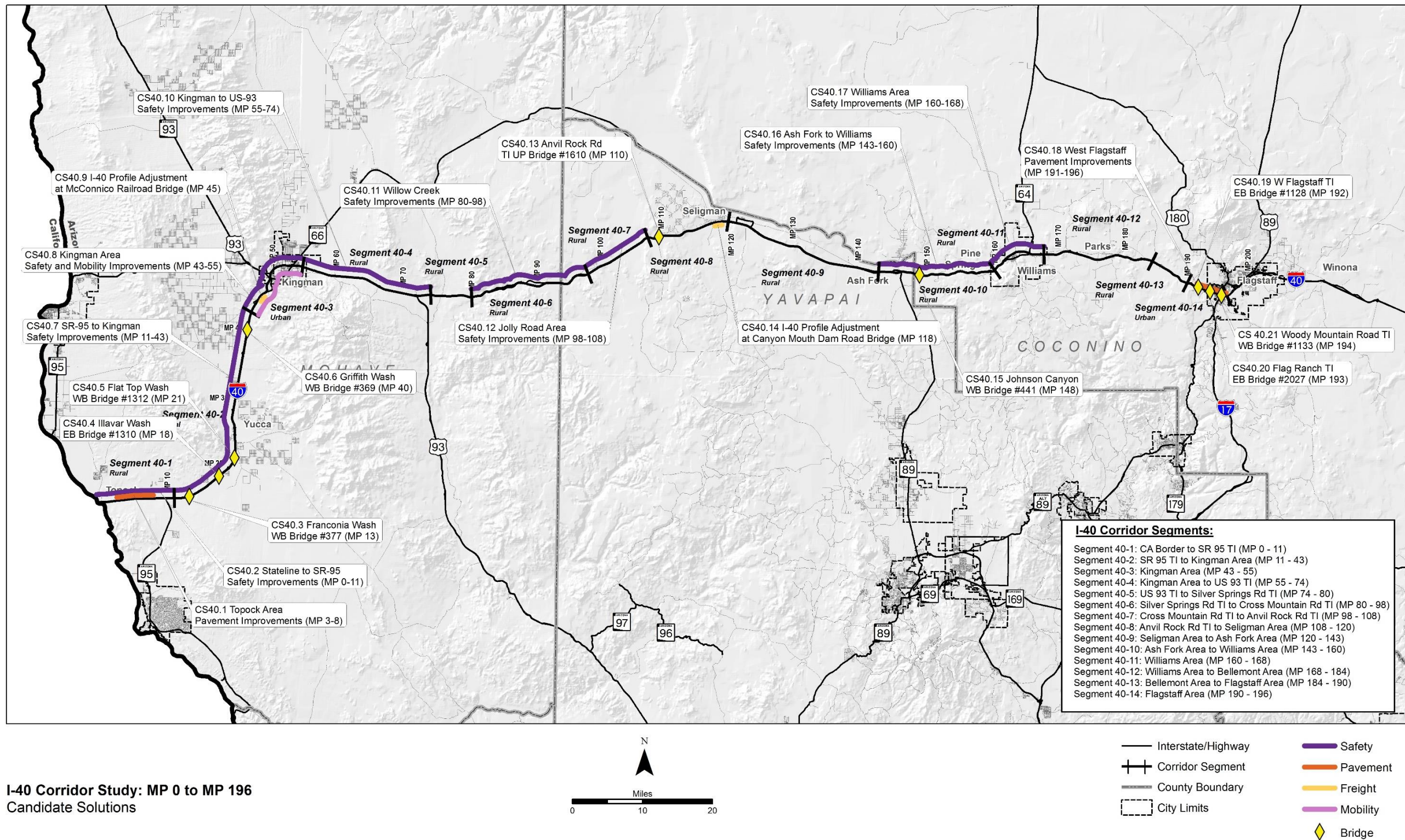


Figure 4: Candidate Solutions

5 NEXT STEPS

The principal objective of the corridor profile study is to identify performance-based strategic solutions (investments) to ensure that available funds result in maximizing the performance of the State's most strategic transportation corridors. Candidate solutions identified in Working Paper 5 will advance to be evaluated in multiple ways including a life-cycle cost or benefit-cost analysis (where applicable), risk analysis, and a performance effectiveness analysis. The methodology and approach to this analysis is briefly described below and will be documented in detail in Working Paper 6. **Figure 5** illustrates the candidate solution evaluation process.

Life-Cycle Cost Analysis – All pavement and bridge candidate solutions have two options: rehabilitate the area of need, or fully reconstruct the issue area or structure. These options will be evaluated through a life-cycle cost analysis to determine the best approach for each location where a pavement or bridge solution is recommended. The recommended option will be advanced to the performance effectiveness and risk analysis evaluations.

Benefit-Cost Analysis – Any strategic issue area that resulted in multiple independent candidate solutions will be evaluated through a benefit-cost analysis to determine the best solution. The recommended option will be advanced to the performance effectiveness and risk analysis evaluations.

Performance Effectiveness Evaluation – After the life-cycle cost and benefit-cost analysis processes are complete, all remaining candidate solutions will be evaluated based on their performance effectiveness. This process will include determining a performance effectiveness score based on how much each solution increases existing segment level performance scores identified in Working Paper 2 and how much the segment level need in Working Paper 4 is decreased. The results of this evaluation will be combined with the results of the risk analysis to determine which solutions have the highest priority.

Risk Analysis – All candidate solutions that are advanced through the performance effectiveness evaluation will also be evaluated through a risk analysis process. This process will examine the risk of not implementing a recommended solution in terms of overall corridor performance. The results of this analysis will be combined with the performance effectiveness scores to determine the highest priority solutions.

The highest ranking solutions will become recommended strategic investments for implementation and compared to recommendations developed through other processes, such as the P2P Link process. Each solution will be assigned to the relevant strategic investment category: preservation, modernization, or expansion.

Strategic investments are not intended to be a substitute or replacement for traditional ADOT project development processes where various ADOT technical groups and consultants develop candidate projects for consideration in performance-based programming in the P2P Link process. Rather, these strategic investments are intended to complement ADOT's traditional project development processes with non-traditional projects to address performance needs in one or a

combination of the five performance areas of Pavement, Bridge, Mobility, Safety, and Freight. Strategic investments developed for strategic corridors will be considered along with other candidate projects in the ADOT programming process.

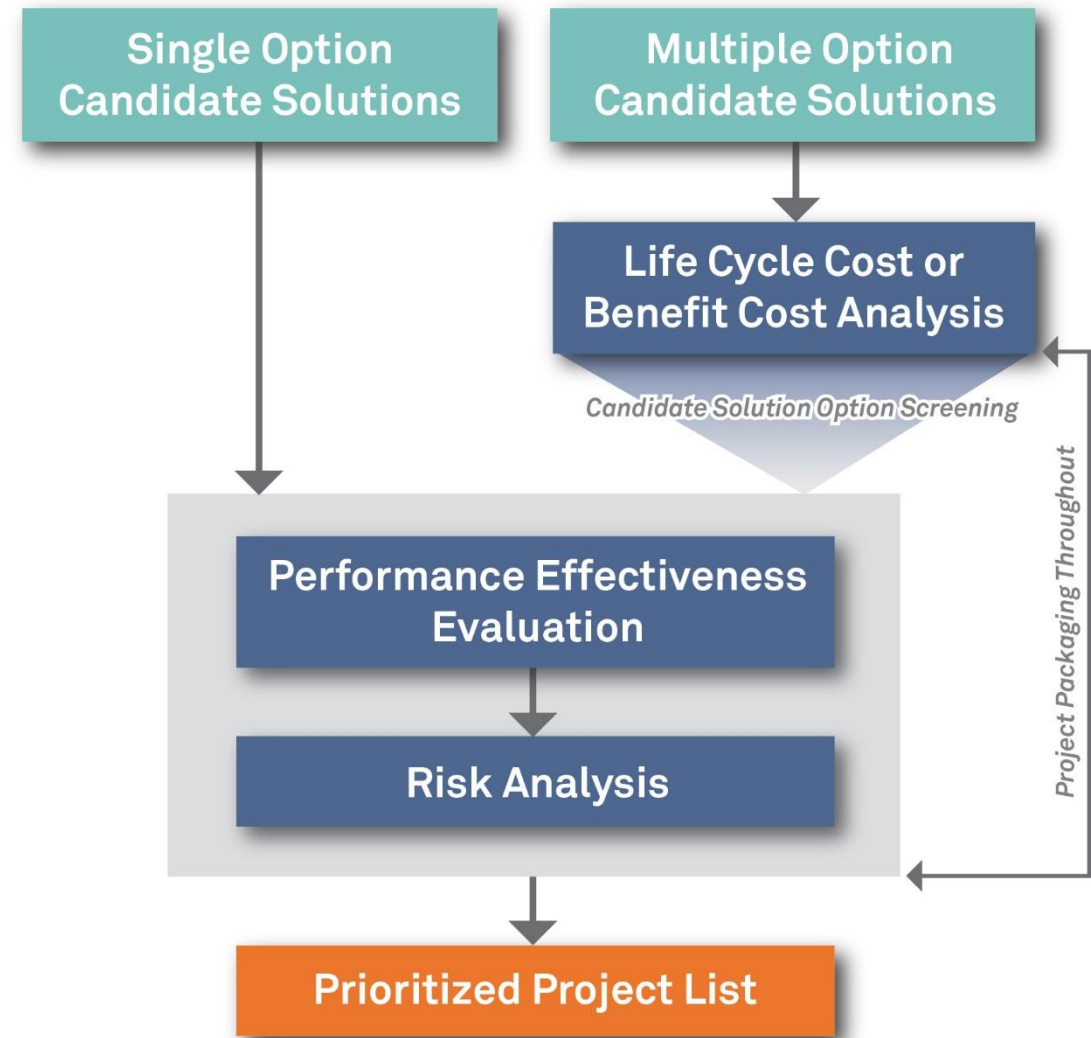


Figure 5: Candidate Solution Evaluation Process

APPENDIX A: *Solution Types*

PRESERVATION

REHABILITATION

- Rehabilitate Pavement
- Rehabilitate Bridge

MODERNIZATION

GEOMETRIC IMPROVEMENT

- Re-profile Roadway
- Realign Roadway
- Improve Skid Resistance

INFRASTRUCTURE IMPROVEMENT

- Construct Auxiliary Lanes
- Construct Climbing Lane
- Construct Reversible Lane
- Construct Entry/Exit Ramp
- Modify Entry/Exit Ramp
- Replace Pavement
- Replace Bridge
- Implement Automated Bridge De-icing

OPERATIONAL IMPROVEMENT

- Implement Variable Speed Limits
- Implement Ramp Metering
- Implement Lane Control
- Implement Shoulder Running

ROADSIDE DESIGN

- Install Guardrail
- Widen Shoulder
- Rehabilitate Shoulder
- Replace Shoulder
- Install Rumble Strip
- Install Safety Edge
- Remove Tree/Vegetation
- Improve Drainage

MODERNIZATION (continued)

ROADWAY DELINEATION

- Install High-Visibility Edge Line Striping
- Install High-Visibility Delineators
- Install Raised Pavement Markers

IMPROVED VISIBILITY

- Cut Side Slopes
- Install Lighting

DRIVER INFORMATION/WARNING

- Install Dynamic Message Sign (DMS)
- Install Dynamic Weather Warning Beacons
- Install Speed Feedback Signs
- Install Chevrons
- Install Warning Signs

DATA COLLECTION

- Install Road Weather Information System (RWIS)
- Install Closed Circuit Television (CCTV) Camera
- Install Vehicle Detection Stations

EXPANSION

WIDEN CORRIDOR

- Construct New General Purpose Lane

ALTERNATE ROUTE

- Pave Alternate Route
- Construct Frontage Roads